(12) UK Patent Application (19) GB (11) 2 283 037 (13) A

(43) Date of A Publication 26.04.1995

(21) Application No 9420987.1

(22) Date of Filing 18.10.1994

(30) Priority Data
(31) 08141298 (32) 21.10.1993 (33) US

(51) INT CL[6]
E21B 10/22

(52) UK CL (Edition N)
E1F FFG

(56) Documents Cited
US 5358061 A US 5080183 A US 5056610 A

(58) Field of Search
UK CL (Edition N) E1F FFG
INT CL[6] E21B
Online: World Patents Index

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(54) Seal protection for rock bits

(57) Sealed bearing roller cone rock bits are prone to seal wear and failure due to the encroachment of abrasive drill cuttings into the seal gland 21. A hard metal cuttings diverter pad 23 angularly positioned across the bit leg backface 5, adjacent the trailing edge of the leg shirttail edge 16 relative to cone rotation, wipes the accumulated drill cuttings from the rotating cone backface 30. A circumferential groove 17, formed in the bit leg backface, promotes a relatively high volume flow of drilling fluid at the seal gland entrance to flush away the abrasive cutting particles not diverted by the hard metal diverter pad.

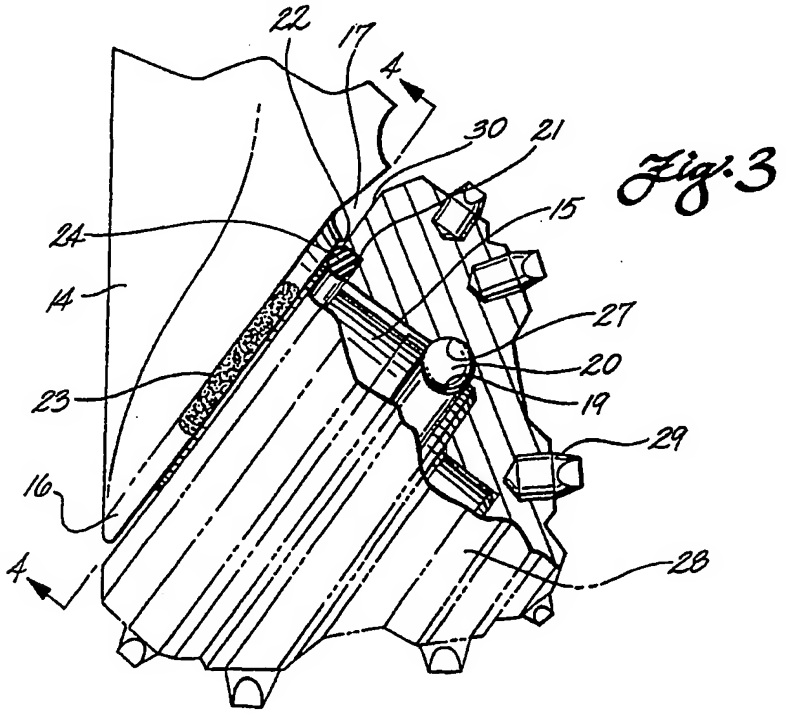

Fig. 3

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

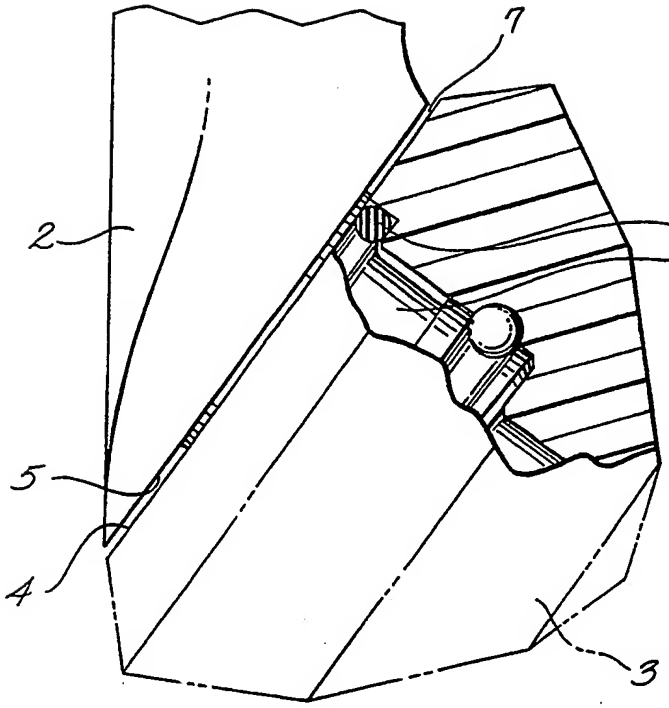


Fig. 1
PRIOR ART

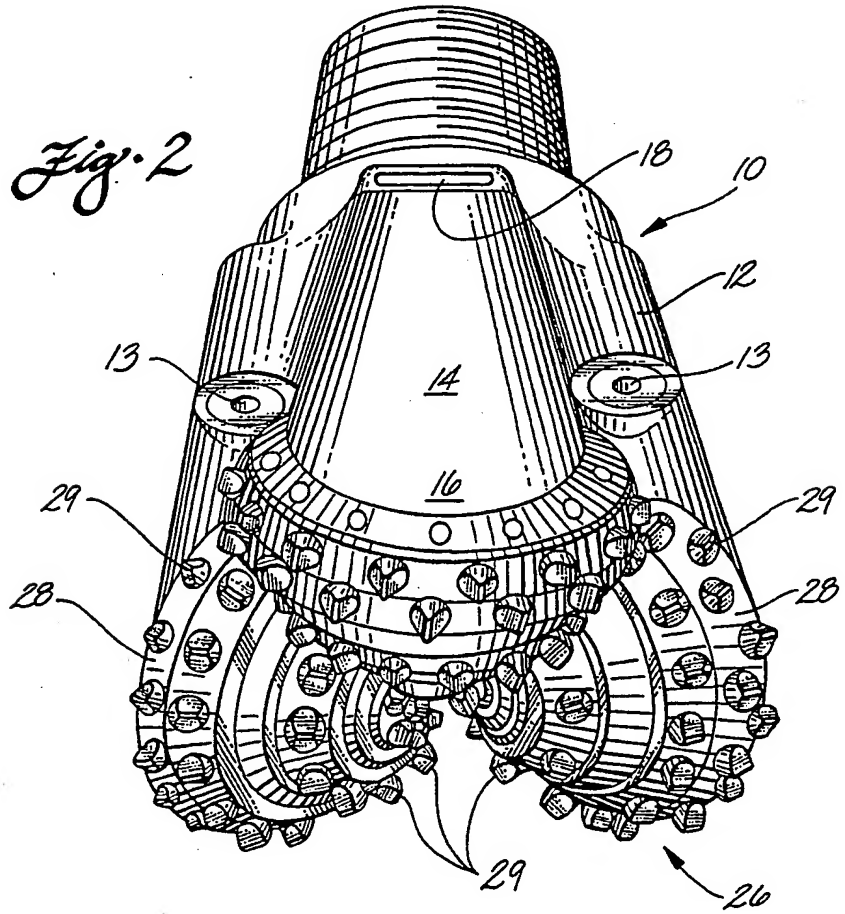


Fig. 2

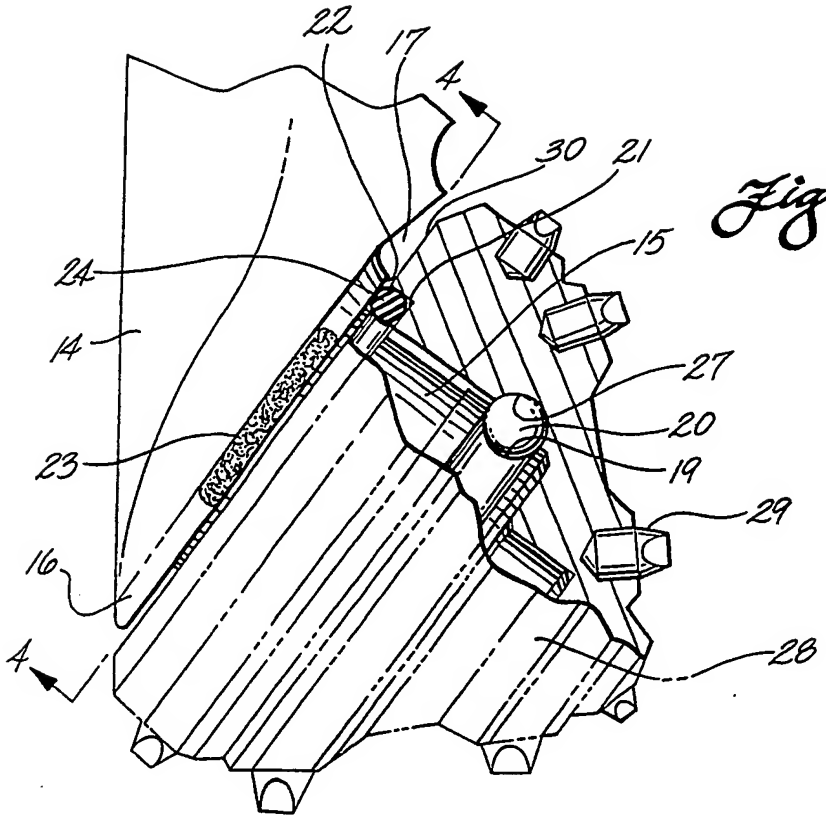
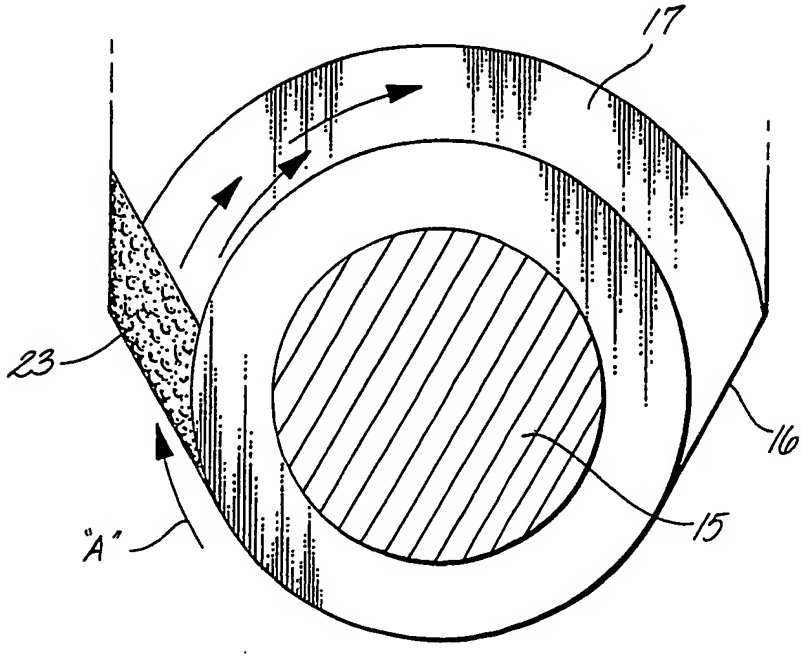


Fig. 3

Fig. 4



SEAL PROTECTION FOR ROCK BITS

This invention relates to rotary cone drill bits and means for preventing drill cuttings from entering the bearings. More particularly, this invention provides a drilled cuttings diverter or barrier in conjunction with a circumferential groove on the backface of the bit leg.

It has long been recognized in the drill bit industry that the longevity of sealed bearing rotary cone drill bits is greatly increased if debris is prevented from entering the bearings associated with each of the rotary cones rotatably retained on the legs of a drill bit. Drill bits used in carrying out rotary drilling are subject to destruction by erosion caused by the abrasive effect of the rock detritus entrained in the drilling fluid. Fluid circulation is employed primarily to circulate or flush the debris or formation cuttings from the well bore.

In actual practice, mud and solids from the circulating fluid and from the earthen formations pack onto certain portions of the bit structure. This packed material flows or extrudes and moves relative to certain portions of the bit. Since great pressures are utilized in the drilling operations, the movement or flow of this packed material has adverse effects on the bit structure and, in particular, the seal cavity, the seal and bearings associated with each rotary cone of the bit.

U.S. Patent No. 2,960,313 addresses the foregoing problem. Means are provided to mechanically deflect mud and cuttings from a path that normally results in wear and destruction of a roller cone bit. A deflecting post or pin is provided in the leg backface. The end of the pin is adjacent a cone backface, the pin serving to deflect detritus or debris as it invades the space between the cone backface and the leg backface. The pin is fixed in the leg backface and has an exposed

cylindrical end that terminates in a flat surface, the flat surface paralleling the rotary cone backface.

The deflecting post, while being somewhat effective in intercepting the flow of debris, has a circular shape that can divert debris and fluid towards the seal cavity, thus allowing some debris to enter this cavity.

U.S. Patent No. 3,013,621 describes a means to deflect abrasive particles or cuttings from the space formed between a leg backface and a conical cutter. An overlay of hardened materials is welded to the leg backface at an angle to a radial plane from a journal centre line. The abrasion resistant material metallurgically attached to the leg backface serves to scrape or divert debris away from the cone bearings to prevent the debris from entering and destroying the bearing during operation of the bit in a borehole.

This means of diverting the fluid and accumulated cuttings is somewhat ineffective because the space between the leg backface and the cutter backface is very restricted. Therefore, a minimal volume of drilling fluid can be circulated between the cone and the leg backface to flush away the abrasive drill cuttings. This allows intimate contact of the abrasive cuttings with the seal gland, promoting premature seal and bearing failure.

U.S. Patent No. 5,056,610, assigned to the same assignee as the present invention, describes a roller cutter bit having a drill cuttings diverter to prevent packing and abrasion of the bearing seal gland. This diverter consists of a burn plug positioned in the leg backface that is energized to force the plug into contact with the roller cone backface to wipe clean the face proximate the seal gland.

Although this system initially does remove the build-up of detritus at the seal gland area, the hard

metal burn plug wears a circumferential groove in the cone backface near the seal fairly rapidly, exposing the seal to more abrasive cuttings, thereby accelerating seal wear. A significant amount of heat is generated by the plug wearing a groove in the cone, which at times deteriorates the seal.

The present invention has an advantage over the above prior art mechanisms in that the leg backface surface is a recessed circumferential groove instead of a flat surface. A hard abrasive resistant shale diverter pad is affixed fully across the leg backface groove at an angle that is approximately tangent to the seal gland outer diameter so that the outer edge of the pad angles into the direction of the rotation of the cone. The diverter pad wipes the accumulated detritus from the roller cone heel area and the adjacent circumferential groove in the leg backface allows a significantly more than normal volume of drilling fluid to continuously flush the seal gland area clean of cuttings and other detritus.

The foregoing features and advantages are achieved by providing a sealed bearing rotary cone drill bit having a body that has a first pin end and a second cutting end. A downwardly extending leg has an outer surface and a journal bearing integrally formed with the leg and projecting inwardly therefrom. A circumferential groove is formed at the juncture of the journal bearing and the leg. A cutter is rotatably mounted on the journal bearing. The cone has a backface that is adjacent to the groove formed on the leg. The enlarged groove provides enhanced fluid flow that removes detritus from the region of the sealed bearing.

The leg further has an angled raised pad of hard, abrasion resistant material that intersects and closes the circumferential groove at the trailing end relative to bit rotation. The hard metal pad also ties

into hard metal on the outer surface of the shirttail.

A rock bit body has a first pin end and a second cutting end. At least one leg extends from the body toward the second cutting end of the bit. The leg rotatably supports the rotary cone from a bearing journal that is cantilevered from the base of the leg. A leg backface is formed by a shirttail formed at the base of the leg. The backface is positioned adjacent a cone backface on the rotatable cone. The leg backface in the shirttail portion forms an enlarged fluid passageway between the leg and the cone backface adjacent the bearing cavity. The enlarged passageway provides a means to allow fluid to flush detritus from the bearing cavity during operation of the rock bit in an earthen formation.

An advantage then of the present invention over the prior art is that the hard metal pad acts as a barrier and prevents the large particles of formation cuttings from going between the cone and leg backface and the greater volume of fluid in the groove scavenges the smaller abrasive particles from the bearing seal interface. Yet another advantage of the present invention over the prior art is that the larger fluid volume in the groove serves to better cool the seal and bearing for longer bit life.

The above noted objects and advantages of the present invention will be more fully understood upon a study of the following description in conjunction with the detailed drawings, in which:

FIGURE 1 is a partial cross section of a prior art sealed bearing rock bit roller cone mounted on a journal extending from the bit leg;

FIGURE 2 is a perspective view of sealed bearing roller cone rock bit;

FIGURE 3 is a partially broken away and sectioned view of the lower end of a leg of a rock bit

illustrating a rotary cone mounted on a journal extending from the leg; and

FIGURE 4 is section 4-4 of Figure 3 showing the backface of the bit leg.

With reference to the prior art illustrated in Figure 1, a sealed bearing roller cutter rock bit leg and cone assembly, generally designated as 1, shows a cone 3 rotatably mounted on a journal 6 cantilevered from a leg 2. The planar surface of the leg backface 5 is opposed by the planar surface of the cone backface 4. The clearance 7 between these two surfaces is normally held to fairly close tolerances to help limit the axial movement of the cone on the journal. This narrow annular space 7 tends to pack with shale cuttings and other debris, which then encroaches on the seal 8, ultimately destroying it. This allows drilling mud and abrasive drill cuttings to enter the bearing cavity, thereby destroying the journal bearing and terminating the bit run.

Figure 2 depicts a sealed bearing rotary cone rock bit, generally designated as 10 that comprises a rock bit body 12, pin end 11 and a cutting end generally designated as 26. Each cone 28 making up the cutting end 26 is attached to a leg 14. Each leg terminates in a shirttail portion 16. Each of the cones 28 has, for example, a multiplicity of strategically spaced tungsten carbide cutter inserts 29 interference fitted within insert holes formed in the cone bodies 28. A lubricant reservoir, generally designated as 18, is provided in each of the legs to supply lubricant to bearing surfaces formed between the rotary cones and their respective journals. Three or more nozzles 13 communicate with a chamber (not shown) formed inside the bit body. The chamber receives drilling fluid or "mud" through the pin end 11. The fluid is then directed out through the nozzles during the drilling operation.

Figure 3 illustrates a leg 14 of the rock bit with a cone 28 mounted on a journal 15. A plurality of cone retention balls 20 are confined within a bearing race 19 formed on the journal and a race 27 formed in cone. An O-ring 24 is retained within a seal gland 21 formed in the mouth of the cone. The O-ring is confined in the seal gland by a leg seal land 22. The O-ring seal serves to retain lubricant within the bearing cavity between the cone and the journal and also serves to prevent drilling mud and detritus from entering the aforementioned bearing cavity. The leg has, at the cutting end 26 of the rock bit, what is known as a shirttail or leg backface 16. The leg backface forms an enlarged circumferential passageway or groove 17 terminating at the lower edges of the shirttail 16. An arc of the groove 17 covers approximately 110° or more around the upper side of the journal, depending on the rock bit size and type. A cross section of the circumferential groove 17 has an arc as an inner boundary with an outer side being tangent to the arc at an angle of about 15° in reference to the leg seal land 22.

Although the cross-sectional geometry of the groove or passageway 17 is essentially triangular, as shown in Figure 3, it may have various geometries such as semi-circular, rectangular or others that fit within the space and strength constraints of bit leg 14. The circumferential groove 17 serves to supply a larger than normal volume of drilling fluid at the upper part of the seal gland 21 to efficiently flush away shale or other drill cuttings to prevent these cuttings from adhering to the cone backface 30 of cone 28 before the cuttings can gain entrance to the seal gland 21.

Figure 4 shows the leg backface groove 17 terminating at the bottom coincident with the lower margins of the shirttail 16. An arrow "A" in the drawing

indicates the direction of rotation of the cone 28. The arrows in the groove 17 indicate the direction of drilling fluid flow through the groove. This fluid flow is enhanced by the rotation of cone 28. A hard, abrasion resistant cuttings or shale wiper pad 23 is shown fixedly positioned, by welding or other means, across the trailing end of the circumferential backface groove 17 in reference to the rotation direction of the cone 28, to minimize detritus being introduced into the groove. The detritus diverting pad can be formed of any material that can be advantageously applied having wear resistance greater than that of the parent metal substrate. For example, the wiper pad material may be selected from cemented carbides of tungsten, titanium or tantalum or mixtures thereof. The hard metal wiper pad blends into the hard metal formed on the lower outer surface of the shirttail to ensure the pad is not undercut by erosion and abrasion to render it ineffective.

The shale diverting pad is at the trailing edge of the shirttail as the bit rotates in the hole, and as the cone rotates relative to the shirttail. The bit rotates left to right in FIG. 4, causing the cone to rotate as indicated by the arrows. Drilling fluid moves through the groove in the direction of the arrows, hence the fluid moves from the trailing edge of the shirttail toward the leading edge. Thus, this is also regarded as the trailing edge of the groove.

The angle of the wiper pad 23 across groove 17 is the angle that will make the trailing side of the pad essentially tangent and coincident to the lower edge of the shirttail 16. The wiper pad 23 can have a width from about 1/8" to 3/4" depending upon the abrasiveness of the rock being drilled and the bit size. The thickness of the pad is as thick as possible without touching or rubbing the backface surface 30 of the rotating cone. The hard

metal pad wraps around the outer edge of the shirttail 16 to prevent the scraped abrasive cuttings from eroding away the base metal of the shirttail.

Field tests have shown that while the circumferential groove alone and the shale diverter or scraper pad alone will each show some decrease in shale or cuttings impaction (shale packing) of the seal gland 21, the use of a combination of the scraper pad in conjunction with the circumferential groove produces a marked improvement of drill cuttings exclusion with a significant increase in bit life.

It will of course be realized that various modifications can be made in the design and operation of the present invention without departing from the spirit thereof. Thus, the present invention may be beneficial to open non-sealed rock bit bearings by preventing the drilled cuttings from entering the bearing cavity thereby increasing the bearing life. Thus, while the principal preferred construction and mode of operation of the invention have been explained in what is now considered to represent its best embodiments, which have been illustrated and described, it should be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

CLAIMS

1. A rotary cone rock bit apparatus to minimize the intrusion of detritus into the bearing cavity formed between a bearing and a rotary cone of the rock bit comprising:

a rock bit body having a first pin end and a second cutting end, at least one leg extending from the body toward the second cutting end, the leg rotatably supporting a rotary cone from a bearing cantilevered from the leg, a leg backface on a shirttail formed at a base of the leg being positioned adjacent a cone backface on the rotatable cone, the leg backface on the shirttail comprising an enlarged fluid passageway between the leg backface and the cone backface adjacent the bearing cavity, the enlarged passageway providing a means to allow fluid to flush detritus from adjacent the bearing cavity during operation of the rock bit in an earthen formation.

2. A sealed bearing rotary cone rock bit apparatus to minimize the intrusion of detritus into the seal cavities formed between a bearing and a rotary cone of the rock bit comprising;

a rock bit body having a first pin end and a second cutting end, at least one leg extends from the body toward the second cutting end, the leg rotatably supports the rotary cone from the bearing cantilevered from the leg, a leg backface formed by a shirttail formed at a base of the leg being positioned adjacent a cone backface formed by the rotatable cone, the leg backface in the shirttail forms an enlarged fluid passageway between the leg and the cone backface adjacent the seal, the enlarged passageway provides a means to allow fluid to flush the detritus from the seal during operation of the rock bit in a earthen formation.

3. A rotary cone rock bit as set forth in either one of claims 1 or 2 further comprising a hard material

detritus diverting pad positioned in the leg backface portion of the shirttail completely across the trailing edge of the passageway at a trailing side relative to cone rotation of the shirttail, the pad being positioned immediately adjacent to the cone backface, the diverting pad serving to wipe away any accumulated detritus from the cone backface.

4. A rotary cone rock bit as set forth in any one of the preceding claims wherein the hard material diverting pad is more wear resistant than a parent metal forming the leg backface.

5. A rotary cone rock bit as set forth in any one of the preceding claims wherein the hard material for the diverting pad is selected from the group consisting of tungsten carbide, titanium carbide, tantalum carbide or mixtures thereof.

6. A rotary cone rock bit as set forth in any one of the preceding claims wherein the passageway extends around an upper part of the bearing.

7. A rotary cone rock bit as set forth in any one of the preceding claims wherein the passageway extends about 110° around an upper part of the bearing.

8. A rotary cone rock bit as set forth in any one of the preceding claims wherein a cross-sectional geometry of the passageway is substantially triangular.

9. A rotary cone rock bit as set forth in any one of claims 1 through 8 wherein a cross-sectional geometry of the passageway is substantially semi-circular.

10. The invention as set forth in any one of claims 1 through 8 wherein a cross-sectional geometry of the passageway is substantially rectangular.

11. A rotary cone rock bit apparatus to minimize the intrusion of detritus into the bearing cavity formed between a bearing and a rotary cone of the rock bit comprising;

a rock bit body having a first pin end and a second cutting end, at least one leg extending from the body toward the second cutting end, the leg rotatably supporting a rotary cone from a bearing cantilevered from the leg, a leg backface formed by a shirttail formed at a base of the leg being positioned adjacent a cone backface on the rotatable cone, the shirttail having hardfacing material formed on a lower outer surface of the shirttail, a hard material detritus diverting pad positioned in the leg backface portion of the shirttail across a passageway formed between the leg backface and the cone backface, the pad blending into the hardfacing formed on the lower outer surface of the shirttail, thereby preventing erosion and abrasion of the parent metal substrate of the leg while inhibiting intrusion of detritus into the seal cavity.

12. A method to minimize the intrusion of detritus into a bearing cavity formed between a bearing cantilevered from a leg of a rotary cone rock bit and a cone rotatably secured thereto comprising the steps of;

forming a passageway in a leg backface on a shirttail portion of the leg, the passageway providing an enlarged opening between a cone backface formed by the cone and the leg backface, the enlarged passageway allowing the detritus to be flushed from an entrance to the bearing cavity.

13. A method as recited in claim 12 comprising forming the passageway around an upper part of the bearing.

14. A method as recited in claim 12 comprising forming the passageway about 110° around an upper part of the bearing.

15. The method as set forth in any one of claims 12, 13 or 14 further comprising the step of applying a hard metal material detritus diverting pad completely across a trailing edge of the passageway at a trailing side of the shirttail relative to the cone rotation, and

positioning the hard metal pad immediately adjacent to the cone backface, the pad serving to wipe away any accumulated detritus from the cone backface.

16. The method as set forth in claim 15 further comprising the step of welding the hard metal pad across the passageway.

17. A rotary cone rock bit substantially as described herein with reference to Figures 2-4 of the accompanying drawings.

18. A method of minimizing the intrusion of detritus into a bearing cavity substantially as described herein.

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report) - 13 -

Application number
GB 9420987.1

Relevant Technical Fields

(i) UK Cl (Ed.N) E1F FFG

(ii) Int Cl (Ed.6) E21B

Search Examiner
MR D B PEPPER

Date of completion of Search
6 JANUARY 1995

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE: WORLD PATENTS INDEX

Documents considered relevant following a search in respect of Claims :-
1-10 and 12-18

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
&	US 5358061	(VAN NGUYEN)	1-18
A	US 5080183	(SCHUMACHER ET AL)	1, 2
A	US 5056610	(OLIVER ET AL)	1, 2

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